CLEOPATRA CRATER, A CIRCULAR PORTAL TO THE SOUL OF VENUS. R. R. Herrick, Geophysical Institute, University of Alaska Fairbanks, Fairbanks, AK 99775-7320 (rherrick@gi.alaska.edu)

Cleopatra crater (Figure 1) is a large (diameter = 105 km) impact crater located high on the flanks of Maxwell Montes, the tallest mountain range on Venus. With an elevation ~4 km above mean planetary radius (Figure 2) and a diameter of 60 km, the area inside Cleopatra's peak ring is the largest high-elevation (relatively) flat area on Venus. Thus, it represents the safest landing spot with a high potential for ascertaining whether elevated tessera terrain, such as Ishtar Terra that contains Maxwell Montes, are compositionally distinct from the volcanic plains sampled by the Venera landers. Geophysical instruments that could evaluate elements of the crust/lithosphere under Maxwell Montes would be critical to understanding the overall interior structure and thermal history of Venus. Through descent imaging and atmospheric sampling, we could decipher some of the unresolved questions regarding the geology of Cleopatra and Maxwell Montes, including obtaining key constraints on why a sharp decrease in radar emissivity occurs with altitude on Venus.

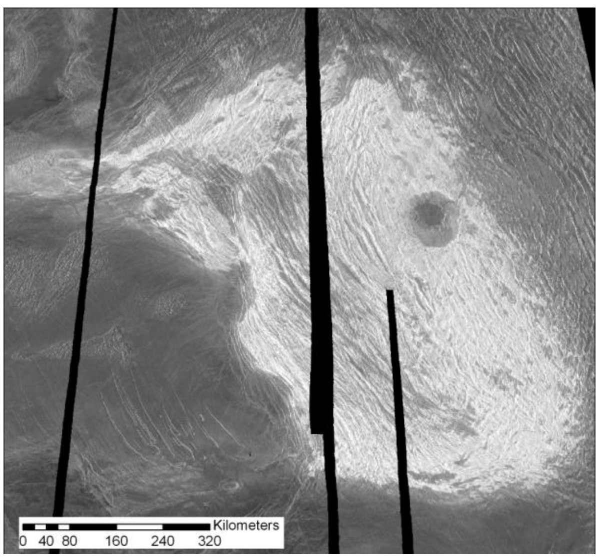

Figure 1. Cleopatra crater is located on the flanks of Maxwell Montes, the highest mountain on Venus, in Ishtar Terra.

Session: This proposed exploration would be in the *Surface* session. Optimally, exploration would be conducted with a lander accompanied by descent imaging and atmospheric sampling.

Target: The target location is the geographic center of the circle defined by the peak ring of Cleopatra Crater, located at coordinates 65.9 N, 7.0 E.

Science Goal(s): As discussed below, this location is designed primarily to understand the composition, crustal/lithospheric structure, and geologic history of a key piece of tessera terrain; this is relevant to investigations II.A.1, II.A.3, II.A.4, II.B.1, III.B.3, and III.B.6, with the specific mention of highlands tesserae in II.B.1 being the most important of these. The ability to address the emissivity "snow line" is most relevant to III.B.3. Also, there are a variety of science questions that can be addressed with descent sampling and lander measurements (e.g., I.A.1, I.A.2, III.A.1, III.B.1, III.B.2) that are not specific to this location.

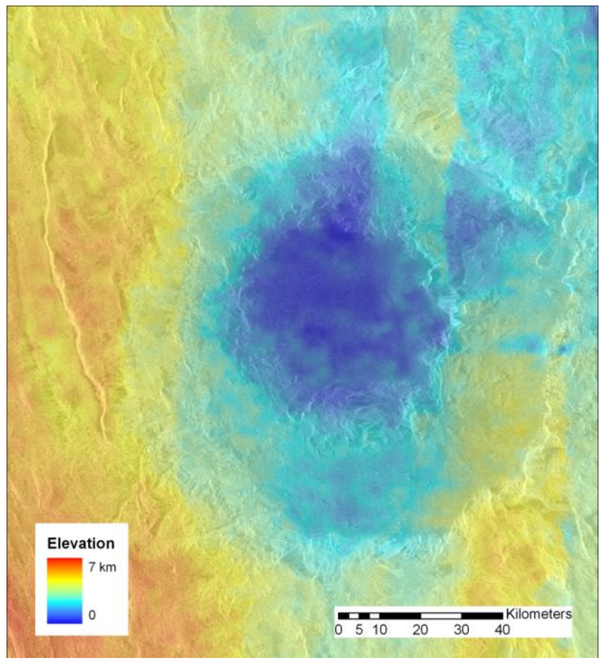

Figure 2. Stereo-derived topography for Cleopatra Crater (step functions in the topography are a result of mosaicking problems with the Magellan data). The elevation scale is relative, and the floor of Cleopatra sits ~4 km above mean planetary radius. Target landing site is the center of the area within the peak ring.

Discussion: Cleopatra crater postdates most, if not all, of the deformation associated with Maxwell Montes, which is part of a larger, tessera-dominated portion of Ishtar Terra (Maxwell Montes grades into Fortuna Tessera, immediately to the East) [1,2]. A landing site located inside the inner ring of Cleopatra would sample rocks that are either 1) impact melt rocks derived from the upper few kilometers of the target, 2) unmelted or partially melted fallback material, 3) xenoliths within the melt sheet, or 4) later volcanic flows (perhaps impact-triggered volcanism [1]). Regardless, the rocks will either be direct samples of highlands tessera terrain or derived from tessera terrain.

For seismology, mountain ranges, especially if they are actively forming, are a likely source for earthquakes, so this location would enhance chances for obtaining interpretable data from single seismometer.

In more general terms, for geophysical studies the benefit of this location is maximized by contrasting measurements here with those from a lander in a "typical" Venusian plains location. Comparing heat flow, seismology, and other direct and indirect measurements in Ishtar Terra versus the plains would provide critical insight for understanding the evolution of the planet's interior.

There are many unanswered questions regarding the relationship of Cleopatra to the mountain range that it sits on. Cleopatra is a very large impact structure. While it is certainly possible that it formed yesterday, the odds of this are extremely low. More than likely, it formed tens of millions of years ago. With what can be observed at Magellan resolution, we end up with the contradictory interpretations that no post-impact volcanism or tectonic deformation of Cleopatra can be clearly identified, but the floor is radar-dark (especially inside the peak ring), the rim is not elevated, and less ejecta than expected is identifiable as superposed on Maxwell Montes [2]. It is an important element of understanding the history of Venus to evaluate whether Maxwell has, in fact, been completely inactive since formation of Cleopatra. If descent imaging could substantially improve on Magellan resolution out to within tens of km of the landing point, then the following critical observations could be made:

- Imaging the rim and immediately exterior to the rim to evaluate where the Cleopatra ejecta is and how it drapes over the mountains.
- Looking for any faulting within the rim or internal to Cleopatra that indicates post-Cleopatra deformation.
- Examining the channel, and draining of Cleopatra, to the NE carefully to determine if this is post-impact volcanism or removal of melt.
- Looking for any post-impact volcanic features within the crater interior.
- Examining the nature of the geologic contact from inside the peak ring to outside.
- Look for faulting associated with the apparent sagging of the interior.
- Seeing if, at a local scale, and in multiple wavelengths, whether the boundary between high and low emissivity features can be examined.

With respect to this last point, atmospheric sampling on the descent could examine how atmospheric conditions change as one goes through the "snowline" elevation of emissivity. Cleopatra is unique in that it is a hole that crosses through the elevation boundary.

For atmospheric sampling after landing, Cleopatra provides an elevated location that, in comparison with any landers in the plains, can provide generic information on gradients of temperature and composition with planetary elevation.

References: [1] Basilevsky A. T. and Schaber G. G. (1991) *LPS XXII*, 59-60. [2] Herrick R. R. and Rumpf M. E. (2011) *JGR, 116*, E02004, doi:10.1029/2010JE003722.